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METHODS

Do declining discount rates lead to time inconsistent economic advice?

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ABSTRACT

This paper addresses the risk of time inconsistency in economic appraisals related to the use of hyperbolic discounting (declining discount rates) instead of exponential discounting (constant discount rate). Many economists are uneasy about the prospects of potential time inconsistency. The paper discusses whether they have reason to be uneasy. The answer is no. The risk of reversing previous recommendations due to the passing of time alone is not severely larger for hyperbolic discounting than it is for exponential discounting. And it can be managed by the same rules of precaution normally used in long term strategic policy decisions and institutional reforms.

1. Hyperbolic discounting and the concern for dynamic consistency

Discounting is an indispensable part of economic appraisal of government policies, programmes, and projects. As indispensable as it is, recent economic research reveals that the traditional exponential method of discounting fails to reflect the certainty-equivalent discount factor when there is uncertainty about the future rate of economic growth and thus the future rate of alternative returns. This is particularly important in appraisals of programmes aimed at conversion from environmentally unsustainable patterns of production and consumption to sustainable ones since the effects of such conversions extend beyond the lifetime of present generations where returns to alternative resource use are fundamentally uncertain. The issue of discounting the distant future is thus intertwined with the issues surrounding the appraisals of environmental programmes and of the balance between future and present generations.

The alternative to exponential discounting is *hyperbolic discounting* characterised by using a declining rather than a constant discount rate — at least for discounting beyond the near future.

A declining discount rate does, however, imply a dynamic inconsistency in the sense that the trade off between consuming in one year rather than in the following years look smaller when regarded at an earlier point of time than when the choice is about the present consumption. This point was already noted by Ramsey (1928). Since then, it has been a central point in the view on discounting in mainstream economics:

> Using a discount rate that depends on the period over which the analysis is being conducted is not without problems. For one thing, it leads to time-inconsistent decisions: plans that people will not follow if given the opportunity to reconsider their actions. This property of hyperbolic discounting functions makes many people uneasy about their use in benefit–cost analysis. Portney and Weyant (1999).

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This paper addresses this uneasiness. Is this dynamic inconsistency a good reason for rejecting the use of declining discount rates in cost–benefit analysis?

The paper starts with a brief summary of some of the most important problems in exponential discounting. The third section presents the alternative, hyperbolic, discounting whereas the problem of dynamic inconsistency is introduced in Section 4. The seriousness of the problem is addressed in Sections 5 and 6 discussing respectively the risk of inconsistent economic advice in appraising the overall net-benefits of a long term programme and in recommendations of a time profile of implementation of such a programme. The conclusion states that the uneasiness is weakly founded.

2. What is the problem with exponential discounting?

There is no consensus amongst economists about the appropriate level of the social discount rate. There is even disagreement as to whether there should be different discount rates for different goods, sectors, and financing arrangements.

Basic economic theory explains the rationality of discounting by consumption time preference and alternative returns to investment. It does, however, also explains a wedge between the two rates of discount due to taxes and asymmetry of information.

Against this background two alternative approaches to discounting have evolved. Consumption discounting uses the social rate of time preference (SRTP) defined as the sum of the rate of pure time preference and the rate of marginal increase in welfare by increasing consumption. Opportunity cost discounting uses the social opportunity cost (SOC) derived from an appropriate sample of market rates of return to investment.

In both cases there are widely differing views on which empirical observations to use and how to adjust them to a discount rate relevant to society as a whole. If we use the SRTP approach, which rate of economic growth should we then assume for the future and which marginal utility elasticity of consumption? If we use the SOC approach, which rate of return should we use? Some consumers borrow on their credit cards at a rate of 15–25% and save at a rate of 4%. Which rate reflects their time preference? And should it be before or after tax?

The standard assumption in neoclassical economics is that consumers ("homo economicus") have identical time preferences that can be represented by exponential discounting. However, as Samuelson (1937) notes, this is an "axiom", "arbitrarily" chosen and not to verify empirically (p. 156). Nevertheless, this assumption was passed on to the Samuelson–Georgescu–Roegen theory of consumption behaviour (Samuelson, 1938) and further to any branch of mainstream economics.

Generally, there is very little empirical support for the assumption that individual time preference can be adequately described by exponential discounting. On the contrary, for the near future (0–5 years) individuals seem to discount with declining discount rates (for an extensive review, see Frederick et al., 2002). Similarly, Brown and Schaefer (2000) find that contradictory to conventional assumptions forward rates in the bond market are not constant but systematically declining in a 25-year maturity perspective due to interest rate volatility. Very few studies have been made with a longer time perspective but a much cited study by Cropper et al. (1992) found in a panel of citizens similarly declining rates of time preference for government programmes with the purpose of saving lives over a longer time perspective. The use of lower discount rates for appraisals of public investments (see Henderson, 1995) also points in that direction.

When the time perspective is extended beyond the lifetime of the present and the next generation, additional problems are added to the choice of discount rate.

With a 5% discount rate, future values are discounted by 95% or more after 60 years. After this point it makes no big difference whether the benefits of the programme last for 20 or 200 years even when that is the point of the programme. Thus, the time horizon of the analysis is in effect restricted by the discount rate. A 10% discount rate reaches 95%-discounting after only 30 years, whereas a 2% discount rate extends this horizon to 146 years. As pointed out by, e.g., Chichilnisky (1996, 1997) exponential discounting means that future effects play no role for the net present value for sufficiently distant effects of present decisions. In this sense, the present would exercise dictatorship over the future by letting decisions be guided only by net present value.

Any investment growing exponentially at a higher rate than the economy would outgrow it in finite time, which would produce absurd results. Rabl (1996) notes that long term discounting with discount rates exceeding the rate of economic growth is only possible based on assumptions that are implausible.

For perspectives beyond 30–40 years, we have little basis for predicting growth rates and rates of return. The finiteness of the planet could lead to an S-shaped growth curve flattening out in the distant future, as has been pointed out by Sterner (1994). The real rate of return to equity stocks have been higher than market interest rates for a long time, but this also reflects an expansion of the corporate sector share of the economy. This expansion has to cease considerably below 100%.

The logic of discounting changes from the logic of intertemporal optimisation of a consumption stream to a logic of intergenerational distribution of consumption opportunities when the time perspective is extended to generations that are separated from the present generation in time. The pure rate of time preference shifts from a preference for consuming now rather than later to a preference for our rather than their consumption. The lack of ethical justification for this preference leads often to an assumption of zero for this parameter. The marginal utility elasticity of consumption on the other hand reflects that an additional unit of consumption will be worth less for the future generations than for the present as they are richer. Therefore, it is ethically justified that additional consumption opportunities counts less for future generations than for the present.

The ethical dimensions of this have given rise to Ramsey's famous view of intergenerational discounting as "ethically indefensible" and an "expression of lack of imagination". On the other hand, not to discount at all would represent a "dictatorship of the future over the present". Thus an ethically acceptable compromise in terms of intergenerational non-dictatorship is required (Chichilnisky, 1996).

Much of the recent interest for discounting the distant future has to do with the concern for environmental qualities the sustaining of which gives the analysis a very long time perspective.

In addition to the long term perspective, environmental losses are frequently characterised by their irreversibility. This irreversibility makes a case for adding an option value to the preservation of the environmental qualities (Arrow and Fisher, 1974; Fisher and Krutilla, 1974). This option value can be expressed in a lower discount rate in cases where such irreversibilities are involved.

There are also reasons to assume that environmental qualities share the high income elasticity of a luxury good implying an exponential growth in the opposite direction of the discount factor (Fisher and Krutilla, 1974; Boiteux, 1976). Solutions to these problems include discounting long term environmental benefits at a low or zero discount rate or accounting explicitly for the assumed changes in relative utilities.

Finally, it can be argued that the rate of growth or the rate of return should be adjusted for the environmental effects that are external to the market. Weitzman (1994) adjusts the discount rate with an "environmental drag" reflecting the share of the consumption opportunities necessary to sustain the environmental qualities in a growing economy. Philibert (1999) suggests an approach that combines these characteristics of the environment in a discount rate adjusted for the lost value of the environmental qualities and obtains a discount rate that is below the rate of economic growth.

How these forces, which are as time and growth dependent as the discount rate, should be included is open to debate. The alternative to adjusting the discount rate for these forces is to account for them explicitly in the valuation part of the studies. Argument in favour of this is that it makes the calculus more transparent and thus the realism of assumptions easier to assess.

3. Hyperbolic discounting: declining discount rates

Recent economic research has remarkably transformed the uncertainty about future discount rates from part of the problem to part of the solution. Gollier (2002) found that taking risk aversion into account makes a case for declining discount rates. Weitzman (1998) found that the certainty-equivalent discount factor is the weighted average of the possible discount factors. It is not, as frequently implicitly assumed, the discount factor resulting from a weighted average of the possible growth rates or rates of return. The corollary of this is that the discount rate must be declining from a present level defined with a reasonable degree of certainty to the lowest imaginable discount rate, possibly zero, in the distant future.

This discovery either solves or reduces many of the problems with exponential discounting described above. In addition to the uncertainty problem described above, the ethical problems and the time horizon and growth rate consistency problems are at least reduced.

It also gives rise to the question of how to define the space of possible future discount rates. One method could be to ask the only people on earth that could be supposed to have a qualified idea about it: the economists. Weitzman (2001) presents a discount factor called "gamma discounting" based on a questionnaire on distant discount rates from a sample of the worlds' economists. Alternatively, previous rates of growth, stock returns, or interest can be used.

According to Newell and Pizer (2003), gamma discounting assumes a space of many possible, but constant discount rates. They find this assumption problematic and suggest instead deriving information about future uncertainty by studying patterns of variations in real interest rates in the past.

Li and Löfgren (2000) present an alternative approach where the social optimum is a compromise between a "utilitarian" representing the present and a "conservationist" representing the future. Their explorations also result in a social discount function with declining discount rates. This result is a contribution to the problem of reconciling the two contradicting discount functions resulting from the Chichilnisky non-dictatorship problem as lined out by Heal (1998).

In a number of European countries, government authorities have recently adjusted their discount rates required for tax financed investment downwards. Discount rate requirements that were settled under impression of the high interest rate regime of the 80s are in any event hard to justify. Her Majesty's Treasury (HMT) in the UK has taken one step further. The formerly high discount rate requirement was among other reasons motivated by the observed tendency to underestimate costs in the investment prospects. This "optimism bias" is now accounted for explicitly and the required discount rate is set at 3.5%. However, only for the first 30 years. After that, it starts to decline, thus following partly Weitzman's gamma discounting and partly Newell–Pizer's empirical founding on historical data (Her Majesty's Treasury (HMT), 2004).

Commisariat General du Plan in France has also recently revised its discount rate recommendation from a uniform 8% to a two tier approach: 4% in the first 40 years and 2% thereafter (Lebègue et al., 2005). The risk of a two tier solution rather than a smooth decline is obviously that just around the 40th year it can mislead recommendations for the time profile of investment.

The reformulation of the social discount rate requirements proceeds along three lines. First, the observed propensity to underestimate project costs ("optimism bias") that has served as justification for a high discount rate is treated by taking uncertainty out of the discount rate and account separately for it in the cost estimation. Second, the economic discount rate is more clearly separated from the financial discount rate and is thus less dependent on periods with tight monetary policy such as the high interest period in the 1980s. Third, the uncertainty about far future discount rates is reflected in declining discount rates. These developments are likely to enhance the information provided by economic appraisals and make them more useful in the policy cycle.

Similar authorities in other countries have revised their discounting guidelines along one or more of these lines or are considering doing it, whereas others seem reluctant to do it for various reasons. Probably the most important argument against this reorientation is the worries about possible time inconsistency.

4. Time or dynamic inconsistency

The case for this concern is simple to understand. A high discount rate represents a high degree of impatience and results in less postponement of consumption and thus less investment. If the discount rate is declining over time, it will be high in the first years and low later on at the time of planning. This could potentially lead to the adoption of a programme and implementation scheme based on the assumption that the citizens are willing to invest less in the early years of the plan and more later on in plan. Then, as time passes and it becomes “later on”, citizens will at that time again have the high short term discount rate and prefer to postpone costs to the subsequent years.

To some social scientists, these concerns would probably appear as an overrating of the significance of cost–benefit analysis in government decision-making to think that the outcomes of cost benefit analyses really control what governments do. It is the same as assuming that economic calculus dominates the political calculus in the policy cycle. However, in any case time inconsistency implies a risk that the same government adviser using the same method to reassess a plan that was recommended in the past and has proceeded according to schedule, when reassessing it, will dismiss the very same plan as sub-optimal. For no other reason than that time has passed.

A trivial effect of such an occurrence could be a loss of confidence in economic appraisals. A more profound question is whether it would have consequences for the efficiency of allocation of productive resources if and when governments actually follow the economic advice.

Newell and Pizer (2001) argue that “Any desire to revise a choice made in the past is no longer determined by the mere passage of time; rather, it is determined by the revelation of uncertainty about interest rates.” (p. 10). In other words: The advice at the outset of a programme may be inconsistent with the advice at a later point of the implementation phase of the programme, but both are consistent with an optimal use of economic resources. This is the result of considering uncertainty about the future returns to alternative uses of the resources of an economic reality and recognizing that this uncertainty diminishes as the future gets closer.

But even if they are optimal in this sense, time inconsistent advice can be a worrying perspective. It could lead to programmes being initiated, but not fully implemented. Or it could lead to regretting that a programme was not initiated decades ago.

In a recent paper Winkler (in press) found that time inconsistency is indeed a realistic risk of plans or programmes with an intergenerational time perspective when these are based on hyperbolic discounting. This assertion is, however, only valid for plans consisting of actions that are totally independent and this condition requires some clarification of what we mean by a “plan” or “programme”. In this paper we will use the concept of a “plan” or “programme” to designate a set of means that are perceived necessary to obtain a given set of ends. If the individual means or actions were totally independent it would not be one, but several plans or programmes. The idea of making a plan is to identify all the actions necessary – and only those – to achieve a goal and to design a practicable scheme of implementing them.

The effect of each step in a plan depends on other steps in two ways. They can be complementary dependent in the sense that the effect of one action will not materialise unless the effects of other actions materialise. Introducing alternative motor-fuels for example requires a network of filling stations as well as a fleet of vehicles. The plan will not work without either of them. They can also be sequentially dependent in the sense that the effect of action B depends on the effect of the preceding action A and the subsequent action C.

This conceptual clarification is important for understanding the nature of the costs and benefits of the actions. For example, a bridge consisting of 10 sections does not return 90% of the returns to the entire investment if only 9 sections are installed. In the same way, programmes directed at avoiding a collapse of an ecosystem that almost succeed are not almost as good as those which succeed. It is, indeed, the interdependence of the investments that establishes a need for government planning. If the investment of each year was independent of the investments of other years, there would be no reason for planning in the first place.

There are important differences between financial savings and the physical and social changes accomplished by the actions of a plan. Whereas the returns to the savings from this year can be enjoyed in the future totally independent of the savings in previous and subsequent years, the effects of actions in a plan depend on whether the other actions are successfully carried through. If it is necessary to obtain a particular stock of financial assets as it is for obtaining an acceptable living standard when retired, it is necessary to commit to a pension plan. In a pension plan, the contribution from each year is necessary to obtain the acceptable standard of living. If one fails, then, in principle, the standard of living of the retiree will be unacceptable.

What are the risks of giving time inconsistent advice concerning a government programme even if implementation proceeds as planned and nothing else changes except that the discount rate declines as time passes? The question dissolves in two sub-questions: What is the risk of dismissing an originally recommended programme before it is completed? What is the risk of recommending a time profile for the implementation plan and then, when it comes to the actual implementation, recommend another profile?

5. Dynamic consistency in the economic assessment of a coherent plan

Consider a typical plan that gives no reward to investment before completion of the plan and where past investments are sunk costs because they are irreversible. They cannot be converted to financial assets and used for some other purpose. Assume that the costs and benefits have well defined cash equivalents. Set an initial net-cost period to

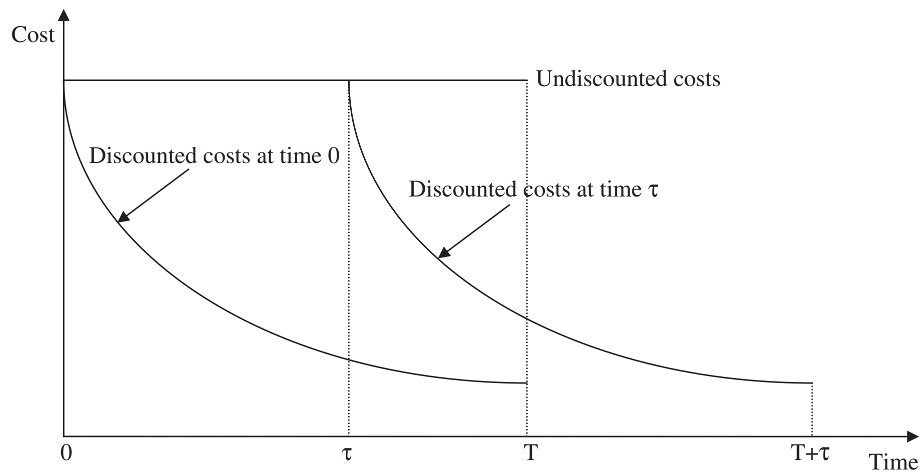

Fig. 1 – Comparison of present value of costs at different points of time for any discount function.

time $t=0,\ldots, T$, and a subsequent net-benefit period with time $t=T+1,\ldots, \infty$. Assume for simplicity that net-costs are constant: $c_t=c=C/(T+1)$. In other words, the total net-effort of implementing the policy is allocated evenly to all the years where efforts take place. The net-benefits after time T are similarly constant, b for all future. The costs and benefits are discounted to present values with an unspecified discount function $\Phi=\Phi(t)$, $\Phi(0)=1$, $0<\Phi(t)<1$ for $t>0$, $\Phi'(t)<0$. These properties are shared by exponential as well as hyperbolic discount functions.

The net present value of the plan will then be

$$\mathrm{NPV}_0 = -\int_0^T c\Phi_t \mathrm{d}t + \int_T^\infty b\Phi_t \mathrm{d}t \tag{1}$$

If the economics of the plan was to be reassessed at a later point, say, $t=\tau$, $0<\tau<T$, the present value would at that time be

$$\mathrm{NPV}_\tau = -\int_\tau^T c\Phi_{(t-\tau)} \mathrm{d}t + \int_T^\infty b\Phi_{(t-\tau)} \mathrm{d}t \tag{2}$$

The first term in Eq. (1) can be split into two integrals:

$$\int_0^T c\Phi_t \mathrm{d}t = \int_\tau^T c\Phi_{(t-\tau)} \mathrm{d}t + \int_T^{T+\tau} c\Phi_{(t-\tau)} \mathrm{d}t \tag{3}$$

Since the first term on the right hand of Eq. (3) equals the present value of net-costs in Eq. (2) and the second term on the right hand is always positive, the net present value of the cost part of the plan will always be less at any "present" time τ than at time 0.

The figure below (Fig. 1) shows the discounted costs of the programme at the outset compared with the discounted costs for the rest of the programme at time τ.

The figure shows that the discounted costs for the rest of the implementation period at time τ (the area below the "Discounted costs at time τ" from τ to T) is smaller than the discounted costs for the entire implementation period (the area below "Discounted costs at time 0"). Simply because the area below "Discounted costs at time τ" to the right of T is positive and the area below the curves otherwise are identical.

From the point of view of time τ, the anticipated benefit stream will always look more valuable because it is closer in time.

$$\int_T^\infty b\Phi_{(t-\tau)} \mathrm{d}t > \int_T^\infty b\Phi_t \mathrm{d}t \tag{4}$$

This follows from the fundamental assumption that $\Phi'(t)<0$.

The conclusion is that irrespectively of the chosen discount function, net present values of a plan described by a constant annual net-cost from time 0 to T succeeded by a constant annual net-benefit forever thereafter will tend to increase as the implementation proceeds and T is approached.

Even if the assumption of constant implementation costs is relaxed, completion of the programme can be increasingly attractive. The sunk costs at time τ and the increasing present value of the benefits allow for some addition to the present value of the remaining costs of programme before the net present value changes in a negative direction.

6. Time inconsistency concerning the time profile of costs

Consider now the case of a plan with non-constant costs over time. This could be the case of development of conversion to renewable energy technologies. Assume that the first generation undertakes and finances the development of competitive, the second generation implements them in the energy system, and the third, and any subsequent generation, enjoys the opportunity to expand their energy consumption without jeopardising climate stability, local air pollution, and strategic independence. It must be admitted that the values of these opportunities are probably not possible to quantify with any degree of certainty that makes them applicable for an economic calculus. But assume that the first generation bears the largest costs, whereas the second generation only carries minor net-costs, and the third generation gets net-benefits. Following the logic in the preceding section, completion of the plan would appear to be ever more attractive as the time passes. If it was a beneficial strategy for the first

Table 1 – Changes due to the passing of time of the NPV of a 500 year programme decomposed on phases

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
HMT discounting													
Phase 1	−86	7	8	8	8	8	9	9	9	10	10	0	0
Phase 2	−934	−28	−29	−30	−31	−32	−33	−35	−36	−37	−39	12	12
Phase 3	1664	17	17	18	18	19	19	20	21	21	22	22	23
Entire programme	643	−4	−4	−4	−5	−5	−5	−6	−6	−6	−7	34	35
3.5% exponential													
Phase 1	−86	7	8	8	8	8	9	9	9	10	10	0	0
Phase 2	−861	−30	−31	−32	−33	−35	−36	−37	−38	−40	−41	9	10
Phase 3	356	12	13	13	14	14	15	15	16	16	17	18	18
Entire programme	−590	−10	−11	−11	−11	−12	−12	−13	−13	−14	−14	27	28

Change in units from the preceding year.

generation, then it is even more beneficial for the second generation to use the technologies because they are already paid for.

But consider now a programme consisting of three sequentially dependent phases, which could resemble a stylised version of the Framework Convention for Climate Change. The first phase is the formation of global institutions that enable the global community to control greenhouse gas emissions in an effective, efficient, and fair manner (Kyoto protocol). The second phase is that the global community uses these institutions to actually reduce greenhouse gasses (Post-Kyoto). In the third phase, the world economy is delinked from greenhouse gas emissions, i.e., the economy can grow without causing greenhouse gas emissions to grow (delinked economy future). In this phase, humanity also enjoys the benefit of being free of risk of man-made disturbance of the radiative balance beyond the point where it triggers climate changes that are catastrophic on a global scale. Both types of benefit are beyond quantification and monetisation, but for this academic thought experiment, we can assume that there is a cash equivalent for these qualities.

Assume that the Post-Kyoto phase is much more expensive than the Kyoto Protocol, whereas all the benefits are harvested in the distant future. Is it possible that the net present value of the entire programme would be positive at the start of the Kyoto Protocol phase, but then become negative as we enter the more expensive Post-Kyoto phase?

Assume the first phase is 10 years where 10 units are invested annually. In the second phase 50 units are invested annually over 50 years. In the third phase, which last infinitely, benefits of 100 units are enjoyed every year. That is, we assume that the value of a delinked economy is worth 100 units per year.

The net-present value of the first 500 years of the programme is −590 units discounted exponentially with a 3.5% discount rate. Discounted with the HMT method (3.5% the first 30 years, declining to 1% after 300 years), the net present value becomes positive: 643 units. The contribution to the net present value of the entire programme from each phase is shown in the first column (year 0) of Table 1. The following columns show the changes in the net present value and the contributions from each phase as time passes.

If we move "the present" from year 0 to year 1 and the 500 year horizon similarly to year 501, the HMT net present value decreases to by 4 units. As time passes further, we get, in the same way, a continuously decreasing net present value until we reach year 10. Beyond that point the net present value starts to increase again.

The table shows that the contributions of the individual phases work in opposite direction. The value of phase 1 and phase 3 increases, but the value of phase 2 decreases more than the other two phases increase combined. As the more expensive investments are paid off year by year, we get the same result as in Eq. (4) above.

This mechanism is, however, not a speciality for hyperbolic discounting. The exponential discounting procedure, shown in parallel in Table 1, produces exactly the same pattern. As the more expensive phase comes closer in time, its present value increases and the net present value of the entire programme becomes still more negative. Until we start to work ourselves through the second phase.

The conclusion is that time inconsistent advice in a case with postponed costs can occur. A case with cost figures that produced a positive net present value in year 0 and a negative net present value in year 10 could easily be constructed. But this time inconsistency would be a feature of discounting as such, not of hyperbolic discounting.

In the cases above the sequential dependency of actions or phases are given by the physical and social realities of the world. But what if there are some of the investments that can be allocated freely over the implementation period and the planner seeks to maximise net present value, these costs will be postponed to the latest possible date irrespective of the discounting method. This could in theory lead to a recommendation of another time profile of implementation at a later time inconsistent with the original recommendation.

This is a scenario, which is familiar in daily life household decisions as well as in decisions at organisational levels. Strotz (1955) refers to this as the act of a "naïve planner". The planner optimises net present value without due regard for the nature of discounting. Exactly because it is normal, it is also normal for the planner to take into account the possibility of time inconsistency in the programming. This is done by engaging in "commitments" in which case we have a "sophisticated planner". Strotz (1955) compares this behaviour to Ulysses who asked his men to tie him to the mast.

There is a large literature of evidence that individuals discount the future according to a declining discount rate, that they behave time inconsistently (reviewed in Frederick et al., 2002), and that they therefore engage (voluntarily) in commitments giving them incentives to stick to their plans (see Strotz, 1955 and Elster, 2000 for some important contributions). These commitments can take a wide variety of forms including measures like eliminating options, imposing costs, setting up rewards, creating delays, and even inducing ignorance. Governments can also consider these voluntary commitments insufficient and add requirements as for instance on mortgage amortisation, durability, and scale.

Whereas most of the economic literature focuses on commitments that households engage in, it is also normal procedure in government to institutionalise policies. These institutionalisations of policies include, for instance, broad (bipartisan, cross party) or even consensus based agreements in parliament, international agreements (like the Kyoto Protocol), delegation of decision power to government independent institutions (like central banks) with predefined decision rules, budget rules (e.g., the growth and stability agreement in Europe) and many other arrangements.

The reasons for institutionalising policies in these forms are, however, not time inconsistency due to discounting, but rather due to the possibility of changing political priorities. An uncertainty that otherwise would undermine the credibility of long term policies.

7. Conclusions

The conclusion is that the fear of introducing a time inconsistency in long term planning when using hyperbolic discounting is exaggerated.

First, the uncertainty of the economic development in the distant future is a reality that means that certainty-equivalent rates of growth and returns to capital are declining in the distant future. If it is a reality, then not taking it into account necessarily leads to sub-optimal decisions.

Second, completion of programmes defined as series of actions that are sequentially or complementary necessary to attain a particular goal will be increasingly attractive as the activities are carried through as long as the associated costs are constant and can be considered sunk costs.

Third, time inconsistency can occur in the recommendations for the time profile of implementation when these are based on any discounting procedure. This problem is, however, not difficult to overcome as long as it is known to the planner and engaging in commitments that "insure" against time inconsistency is normal procedure in government.

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